A close-up photograph of a skunk, likely a striped skunk, standing on a light-colored, sandy or dirt surface. The skunk's tail is raised and slightly curved, showing its characteristic black and white stripes. Its head is lowered, and its eyes are visible. The background is a blurred, natural outdoor setting.

# Managing an outbreak of bat rabies in terrestrial wildlife in Flagstaff, Arizona

## Past – Present - Future

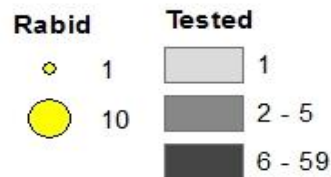
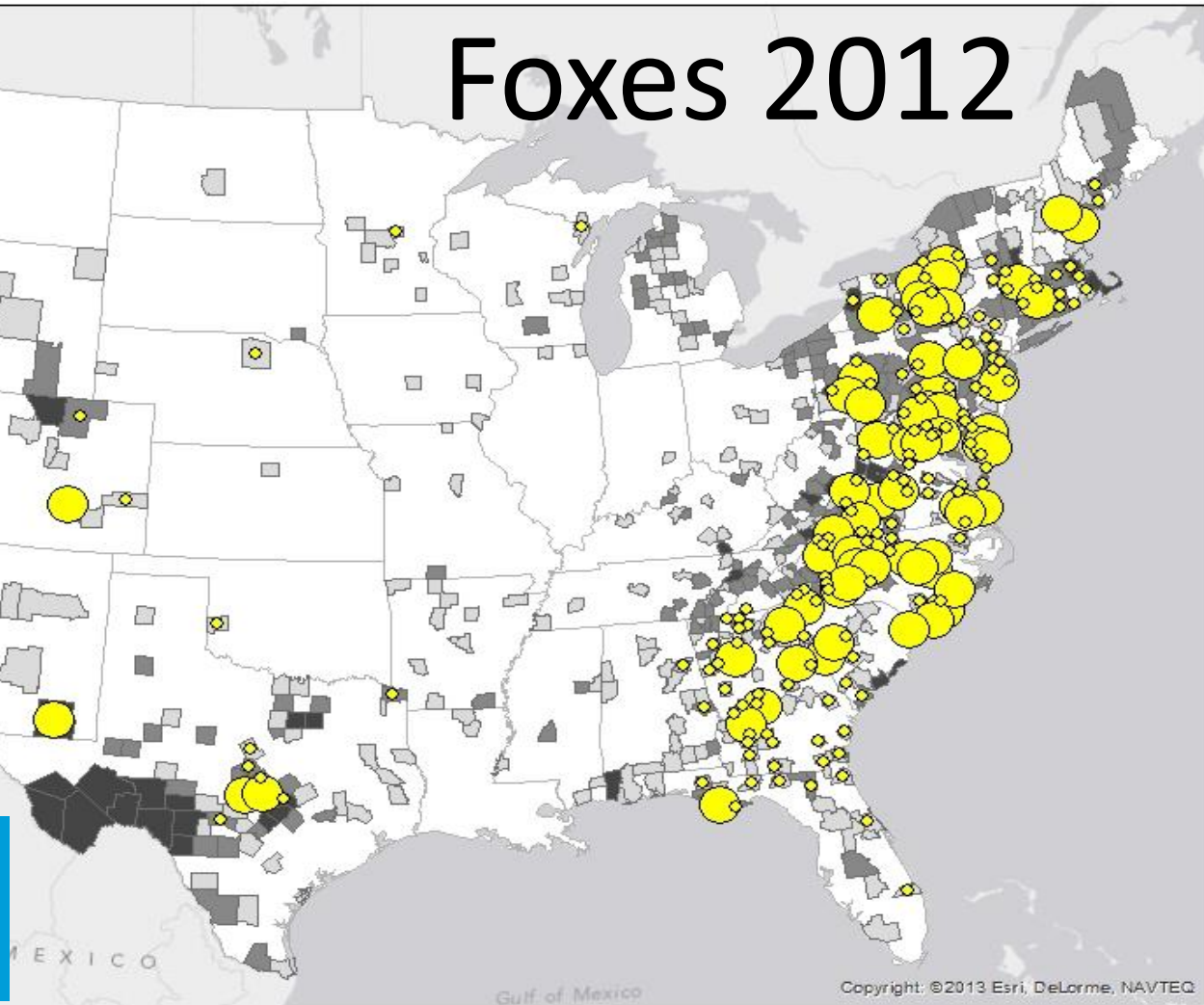
David Bergman  
USDA APHIS WS  
Phoenix, AZ

Tad Theimer  
NAU  
Flagstaff, AZ

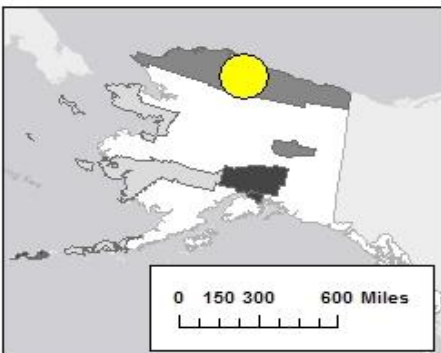
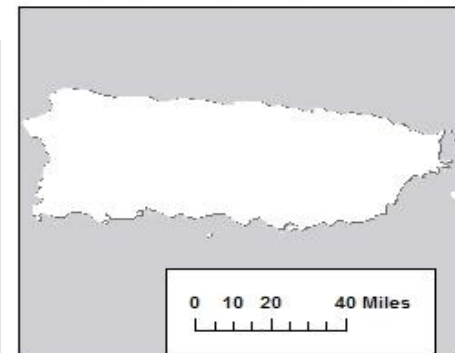
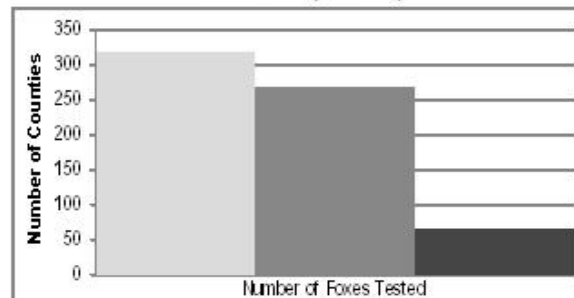
Carol Chambers  
NAU  
Flagstaff, AZ

# Foxes 2012

340 rabid foxes reported  
 – 18.3% tested rabid  
 20.4% decrease from 2011



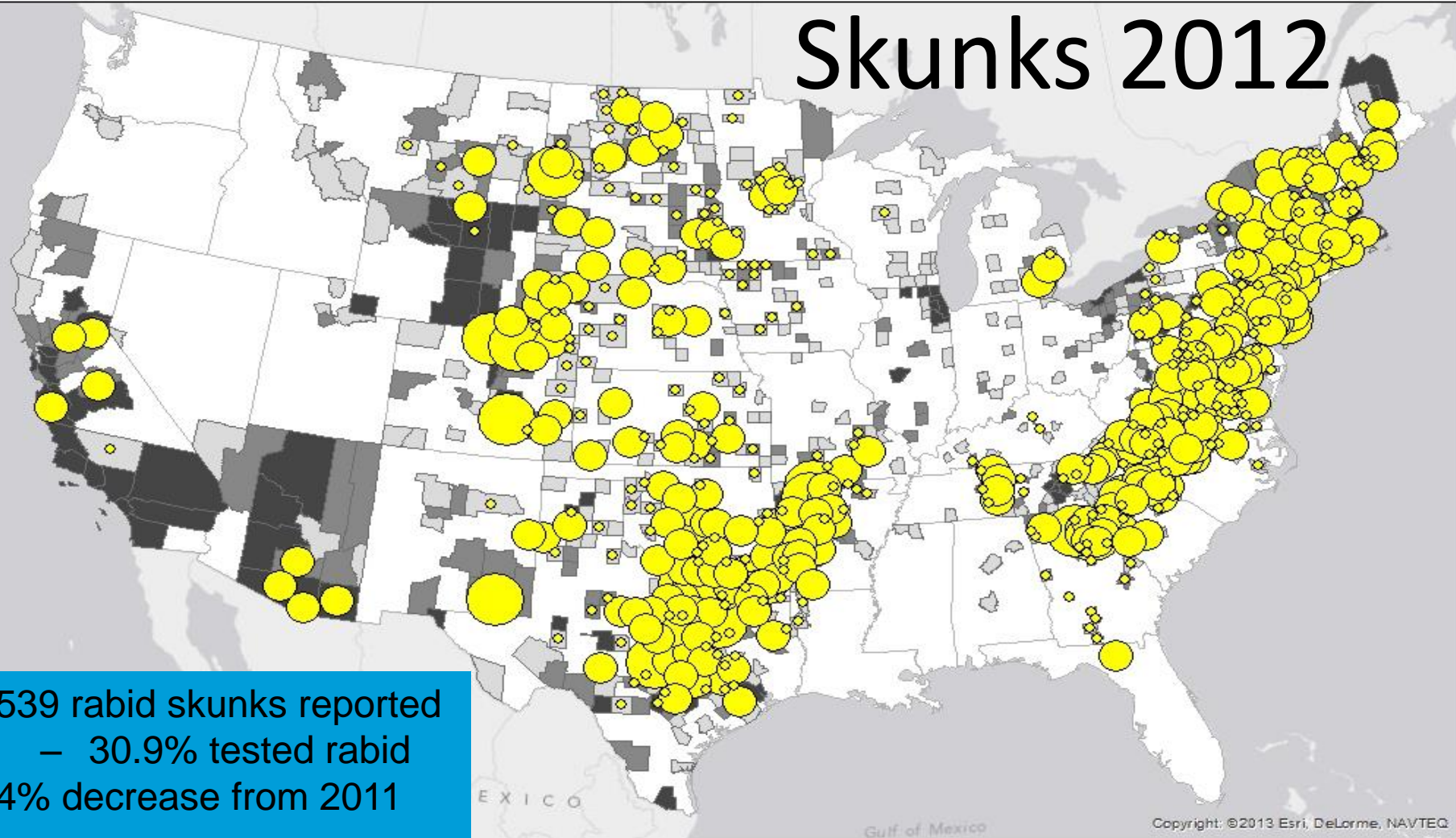
Counties (n= 651)





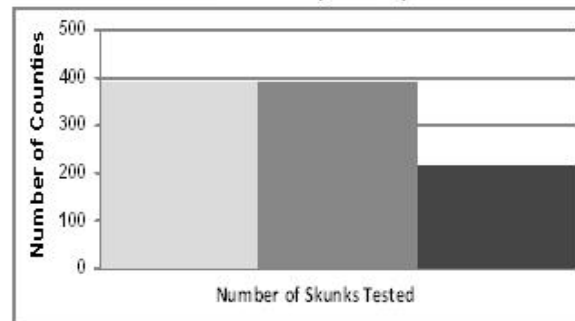
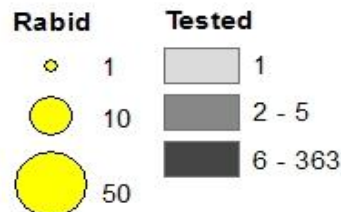
# Skunks 2012

1,539 rabid skunks reported  
 – 30.9% tested rabid  
 5.4% decrease from 2011



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Counties (n= 999)

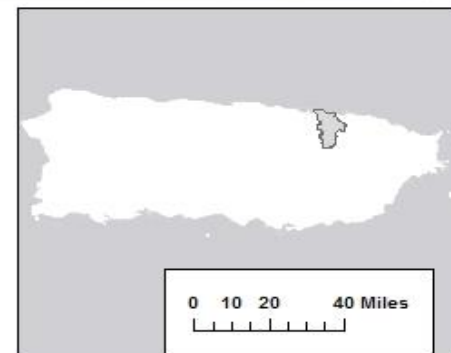
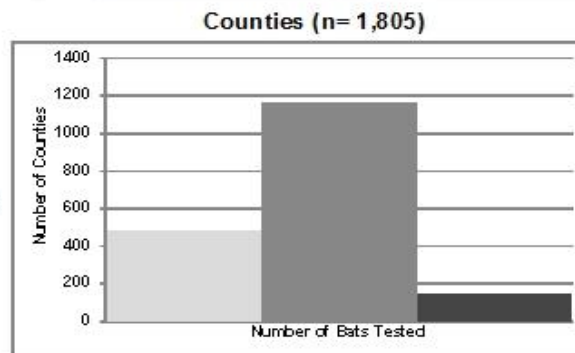
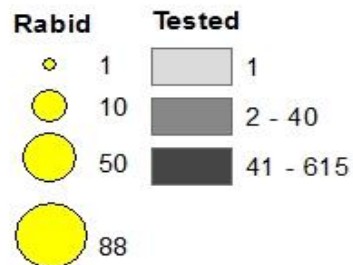


0 150 300 600 Miles

0 10 20 40 Miles

# Bats 2012

1,680 rabid bats reported  
 – 6.4% tested rabid  
 21.7% increase from 2011



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## Preliminary 2013 update

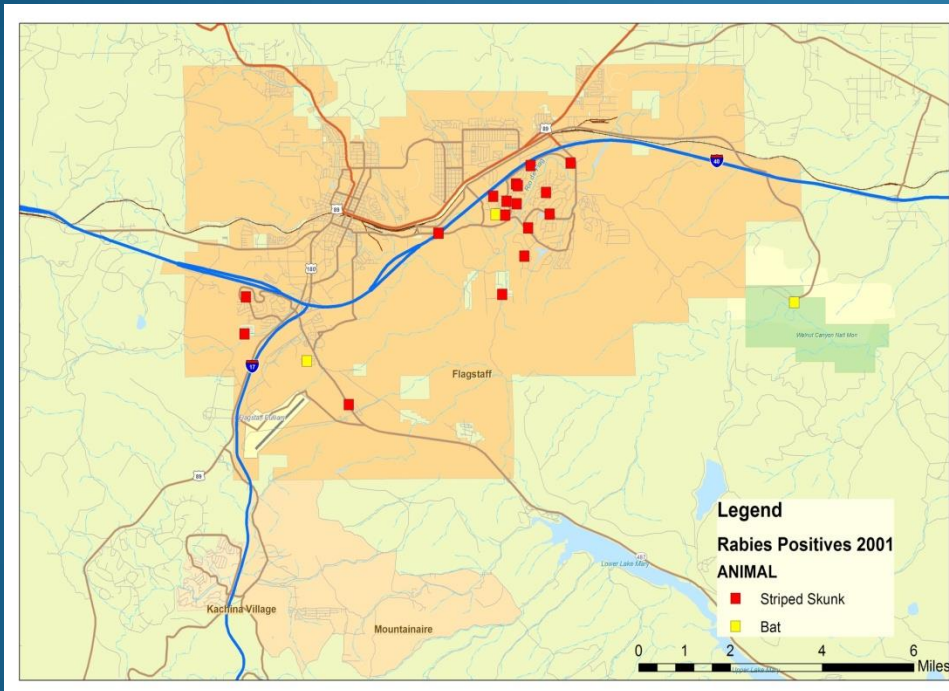
Animal	2013*	2012**	Change
Bats	1203	1173	2.5%
Cats	195	196	-0.5%
Cattle	70	104	-32.7%
Dogs	76	76	0%
Equine	27	44	-38.6%
Foxes	249	245	1.6%
Sheep/Goats	7	11	-36.4%
Raccoons	1366	1381	-1.1%
Skunks	1201	1269	-5.4%

\*89% Reporting (CA, CO, GA, MD, and NY not reported)

\*\*Excluding above states



# Terrestrial Rabies Surfaces in Flagstaff After Nearly 4 Decades



- January 9, 2001, First skunk found with rabies
- TDHS & CDC Identified rabies found in the Flagstaff skunks as a bat-variant of rabies
- 19 skunks test positive for bat-variant of rabies in 2001





TVR



Trap



Vaccinate

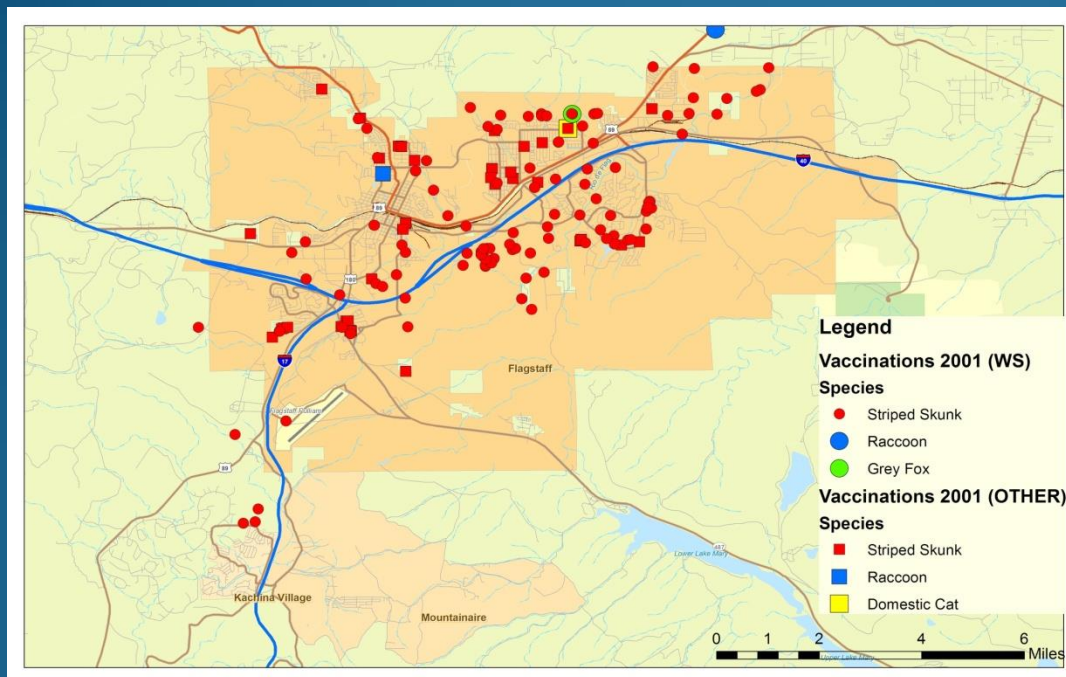


Release



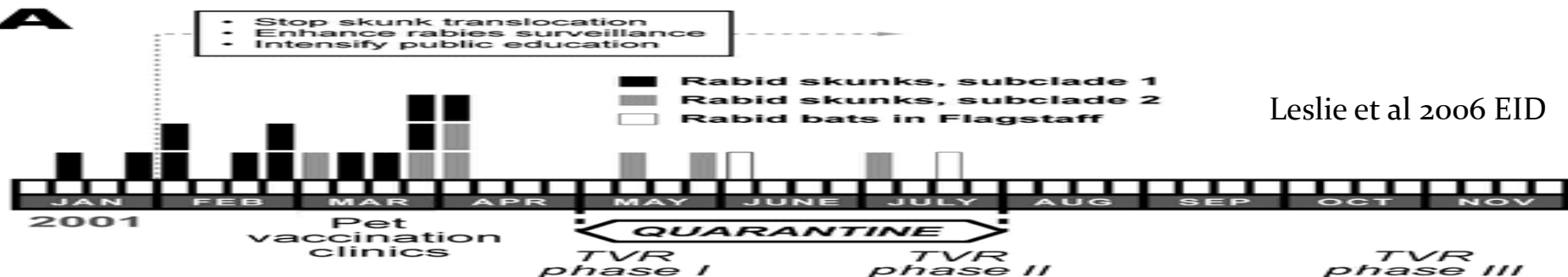


# Intensive TVR Program



- Vaccinations done by WS, CDC, CCHD, and city of Flagstaff

- 217 animals vaccinated and released over 6 months in 2001



Leslie et al 2006 EID



# Rabies Re-emergence in Flagstaff

2004

- 5 striped skunks
- 1 gray fox



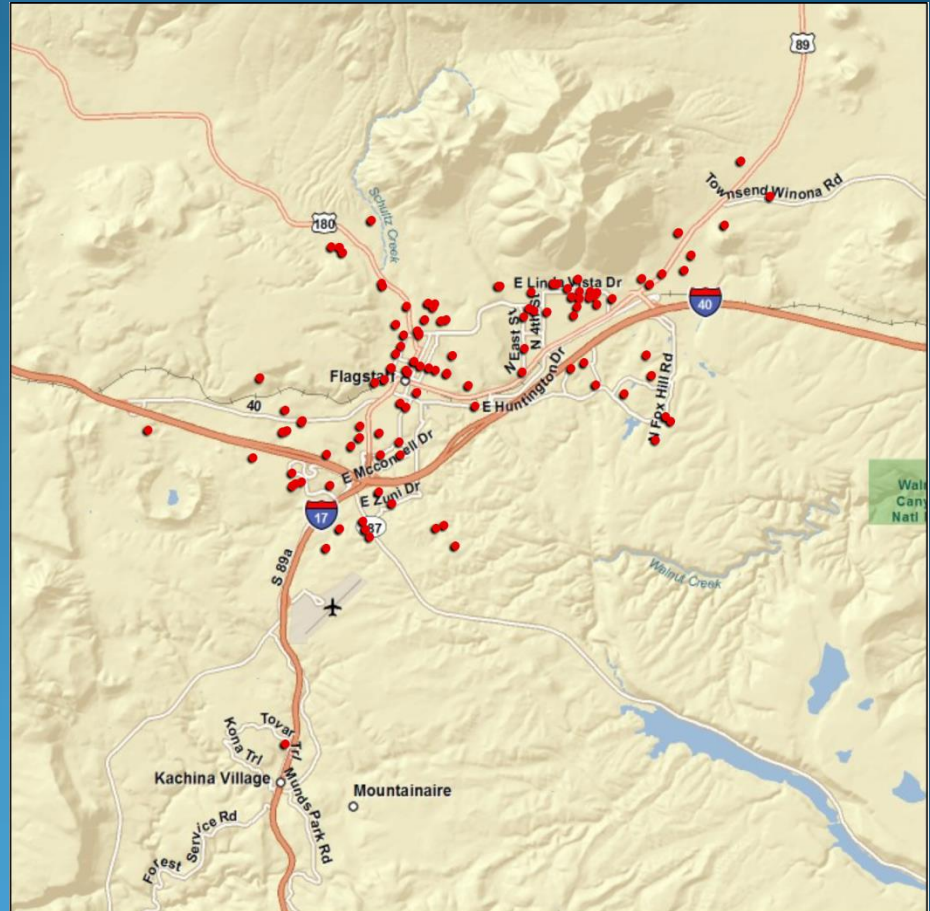
2005

- 1 striped skunk
- 1 gray fox
- 1 domestic cat



# Opportunistic TVR Program

- Cooperate with ACOs, NWCOs, County officials
- Late 2004 through February 2008
- 343 striped skunks, 36 raccoons, 2 hog-nosed skunks, and 1 gray fox were vaccinated and released



No additional rabid animals during TVR



# Oral Rabies Vaccine Study – Striped Skunks

- Test a potential skunk vaccine in the field
- Determine if the bait/vaccine delivery system and vaccine provides adequate rabies titer levels in free-ranging skunks

**FIRST** ORV field trial specifically targeting skunks

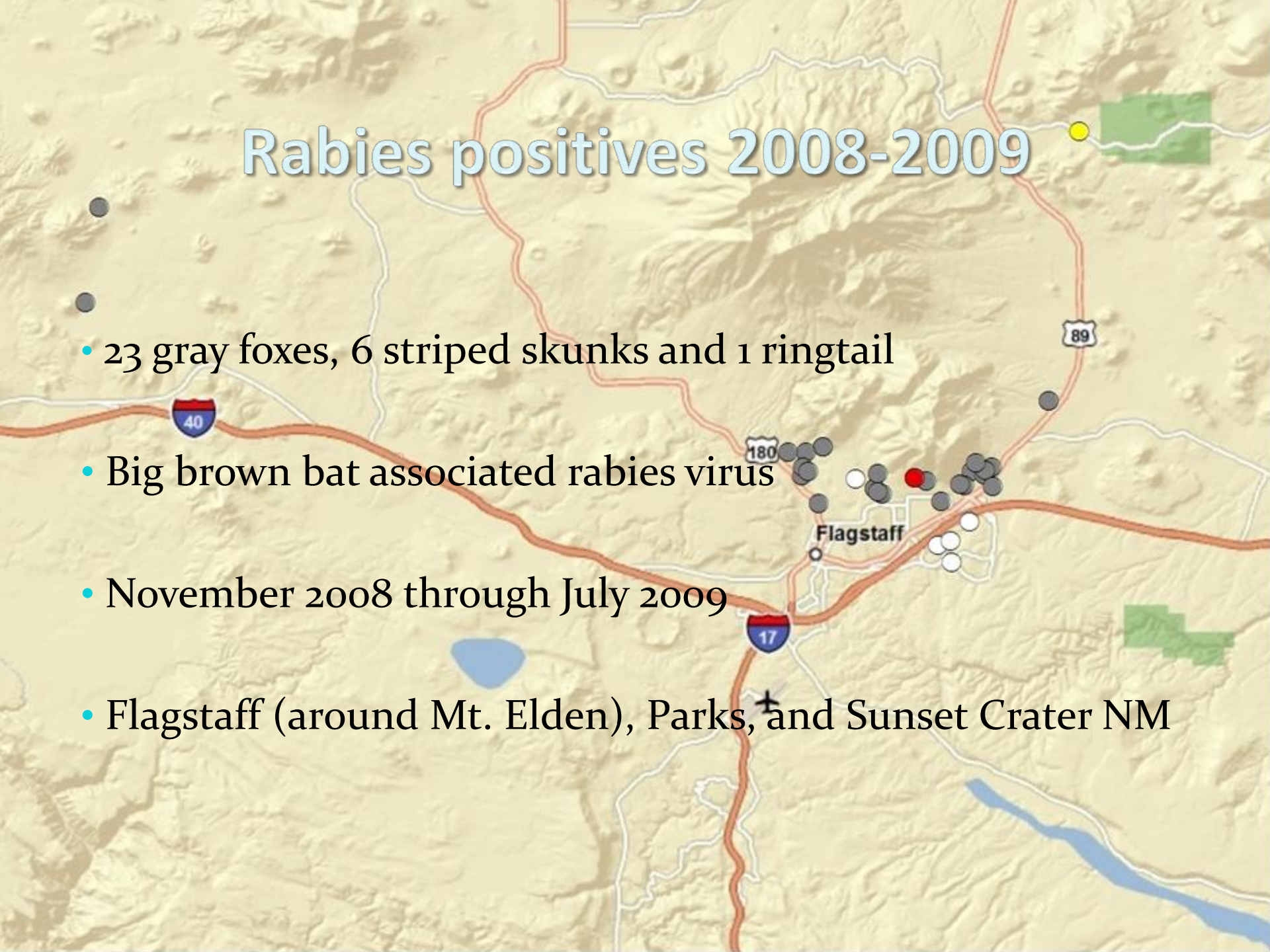
# Vaccine Study Results

- Baited with Raboral V-RG in 2005 and 2006
- 88% of trapped skunks had no antibody response
- 12% had measurable rabies viral neutralizing antibodies (rVNA)
- Only 1 skunk had measurable rVNA without record of previous vaccination
- 10 skunks had visible biomarker without developing rVNA
- Direct installation may be effective at protecting animals against rabies challenge (Grosenbaugh et al. 2007), but the current bait/vaccine delivery system is ineffective in field settings.

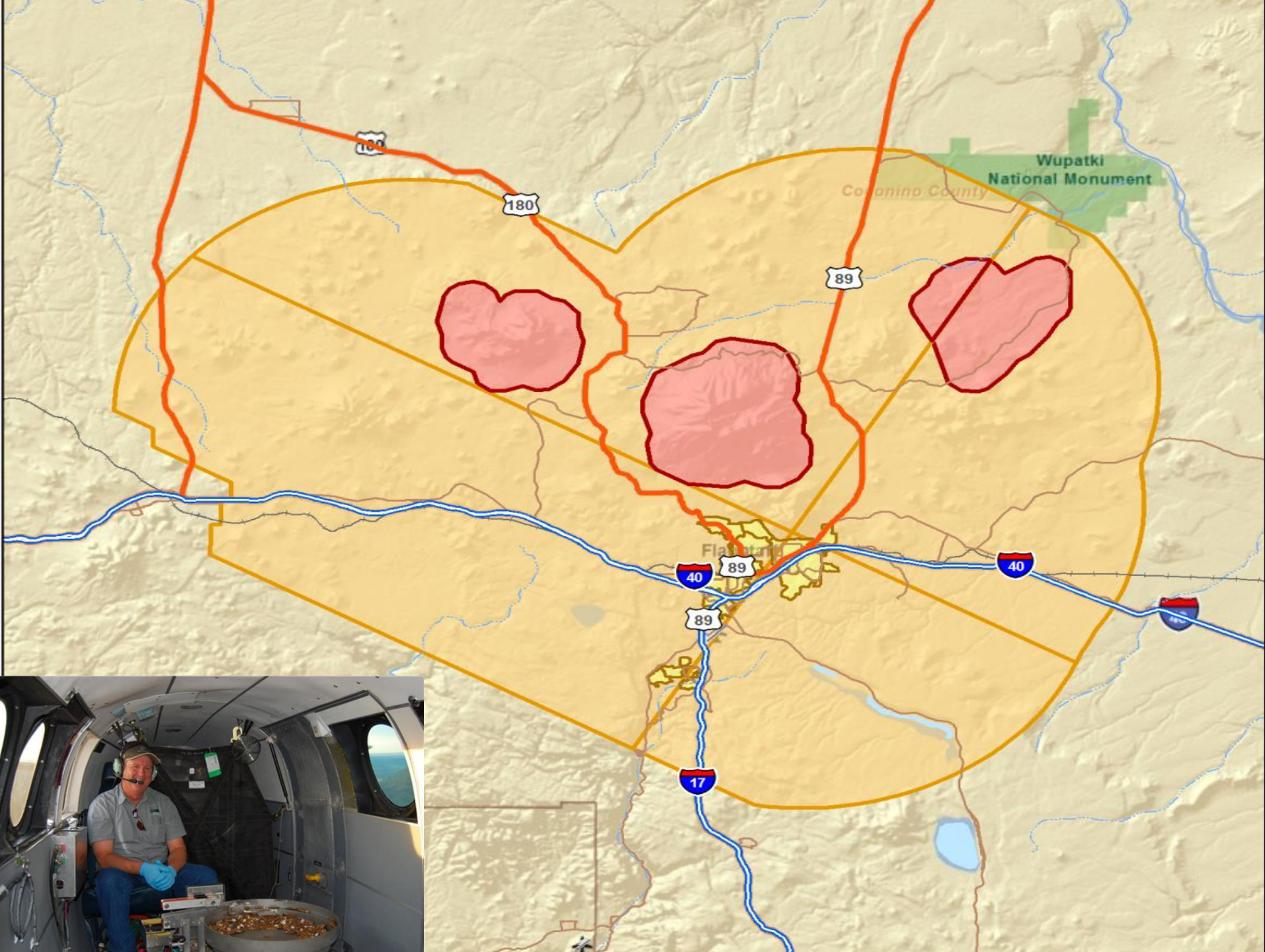


# Rabies positives 2008-2009

- 23 gray foxes, 6 striped skunks and 1 ringtail
- Big brown bat associated rabies virus
- November 2008 through July 2009
- Flagstaff (around Mt. Elden), Parks, and Sunset Crater NM









## Flagstaff

Campaign: Arizona  
Target Species: Gray Fox (*Urocyon cinereoargenteus*)  
Date: July 21 - 24, 2009  
Operational Airport: Flagstaff, Arizona  
Area: 3,712.2 km<sup>2</sup> / 1,433.3 mi<sup>2</sup>

### ORV Distribution by County for Flagstaff

County	Fixed-Wing CS	Ground CS	Total
Coconino	125,278	4,322	129,600
<b>Total</b>	<b>125,278</b>	<b>4,322</b>	<b>129,600</b>

Campaign: Arizona  
Target Species: Gray Fox (*Urocyon cinereoargenteus*)  
Date: June 15 - 18, 2010  
Operational Airport: Flagstaff, Arizona  
Area: 4,104.7 km<sup>2</sup> / 1,584.9 mi<sup>2</sup>

### ORV Distribution by County for Flagstaff

County	Fixed-Wing CS	Ground CS	Total
Coconino	125,609	3,991	129,600
<b>Total</b>	<b>125,609</b>	<b>3,991</b>	<b>129,600</b>

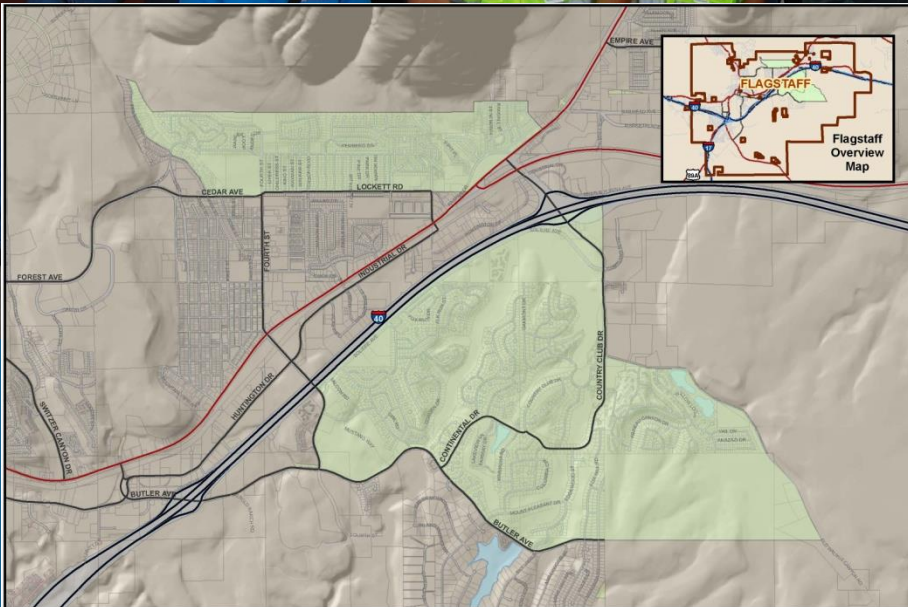
Campaign: Arizona  
Target Species: Gray Fox (*Urocyon cinereoargenteus*)  
Date: August 2 - 5, 2011  
Operational Airport: Flagstaff, Arizona  
Area: 4,104.7 km<sup>2</sup> / 1,584.9 mi<sup>2</sup>

### ORV Distribution by County for Flagstaff

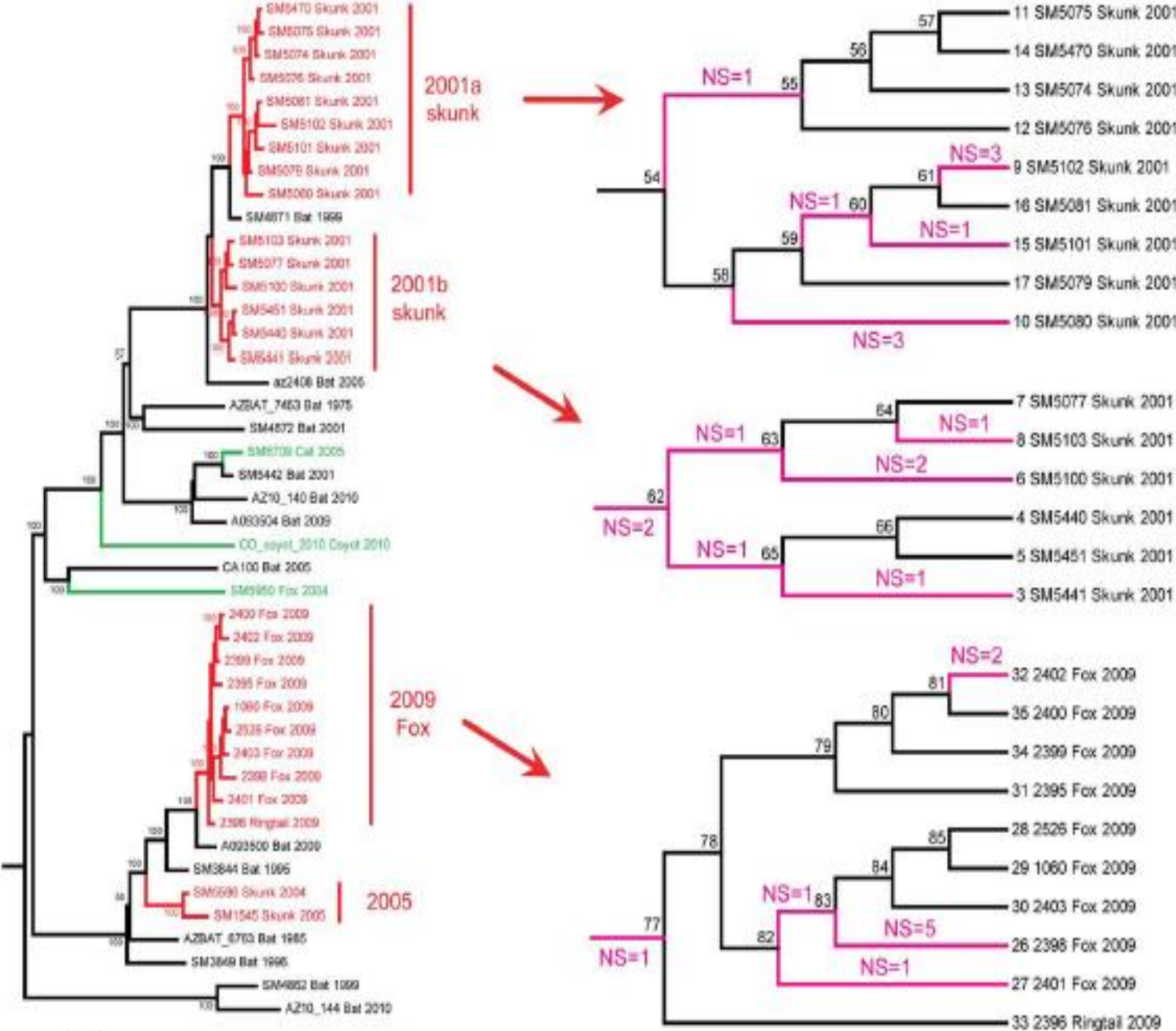
County	Fixed-Wing CS	Ground CS	Total
Coconino	129,237	4,413	133,650
<b>Total</b>	<b>129,237</b>	<b>4,413</b>	<b>133,650</b>

# Combined approach

- Intensive TVR in areas where rabid skunks occur
- July to Mid-September 2009
- 110 striped skunks and 4 raccoons vaccinated

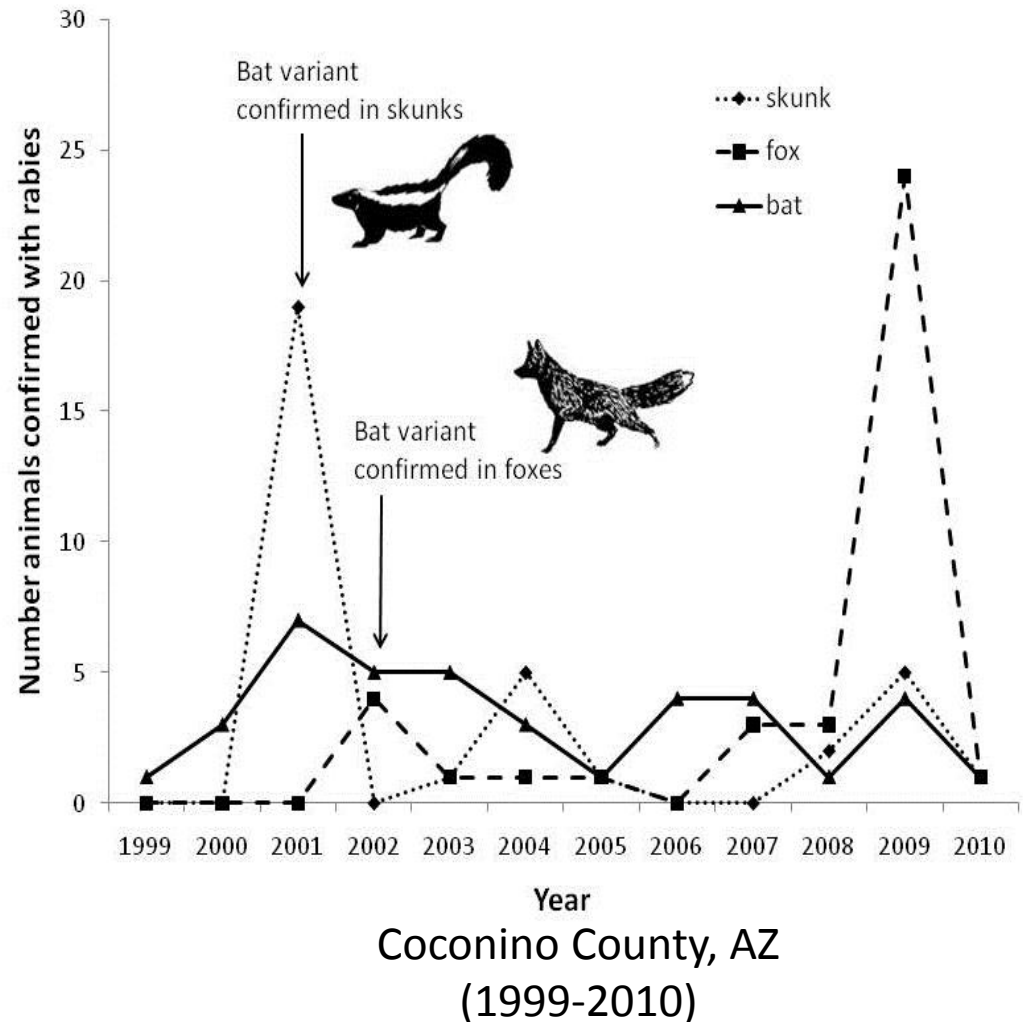






1. What is the life history of big brown bats in a rabies outbreak area?

2. How is rabies transmitted from big brown bats to other animals?





# How?



2008-2012

Coconino County

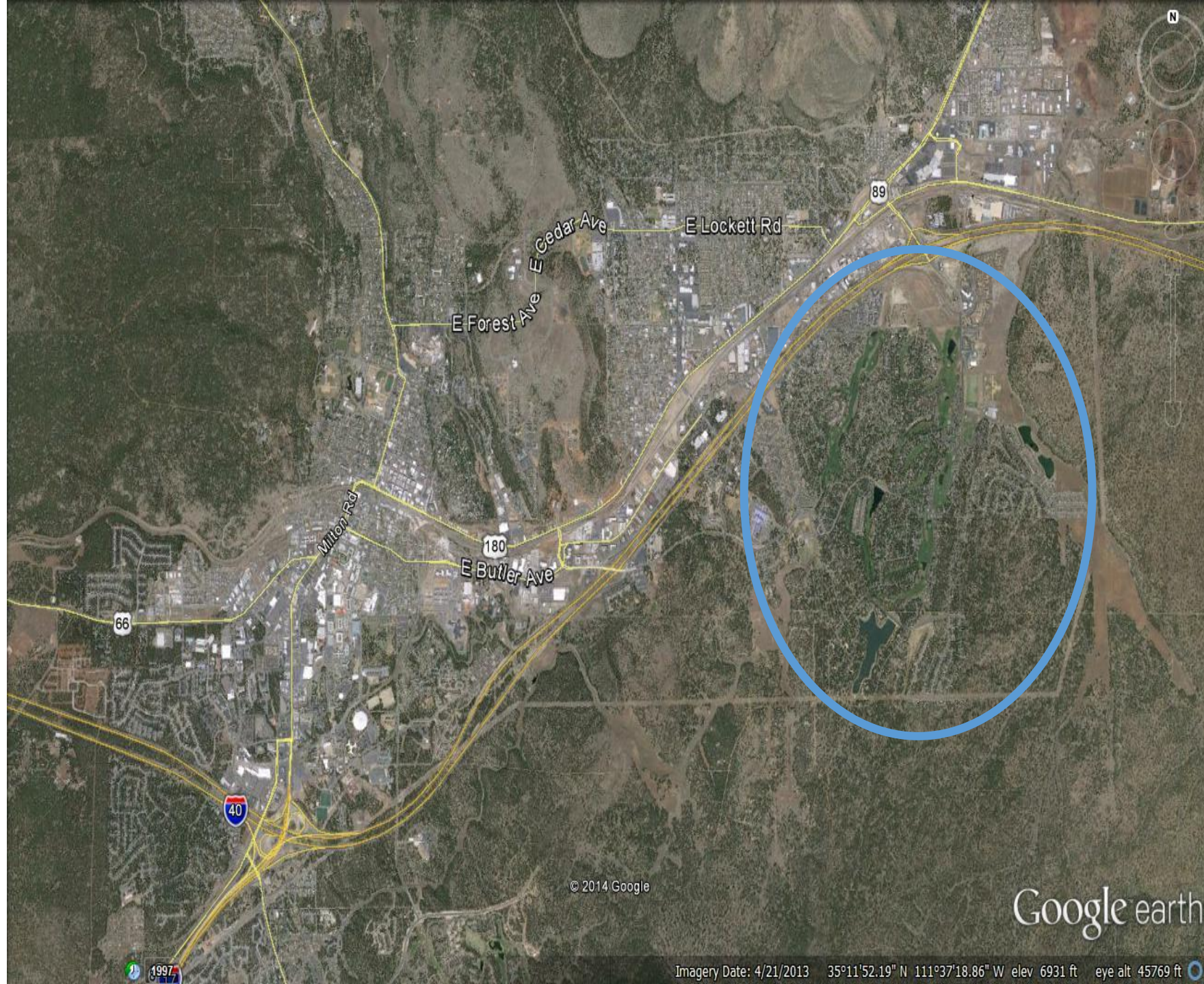
145 big brown bats

10 seropositive for rabies

7%

range 0 to 20%





E Forest Ave  
E Cedar Ave

E Lockett Rd

Milton Rd

180  
E Butler Ave

66

40

© 2014 Google

Google earth

Imagery Date: 4/21/2013 35°11'52.19" N 111°37'18.86" W elev 6931 ft eye alt 45769 ft







2012-2013

325 bats

11 species



Big brown bat

16%



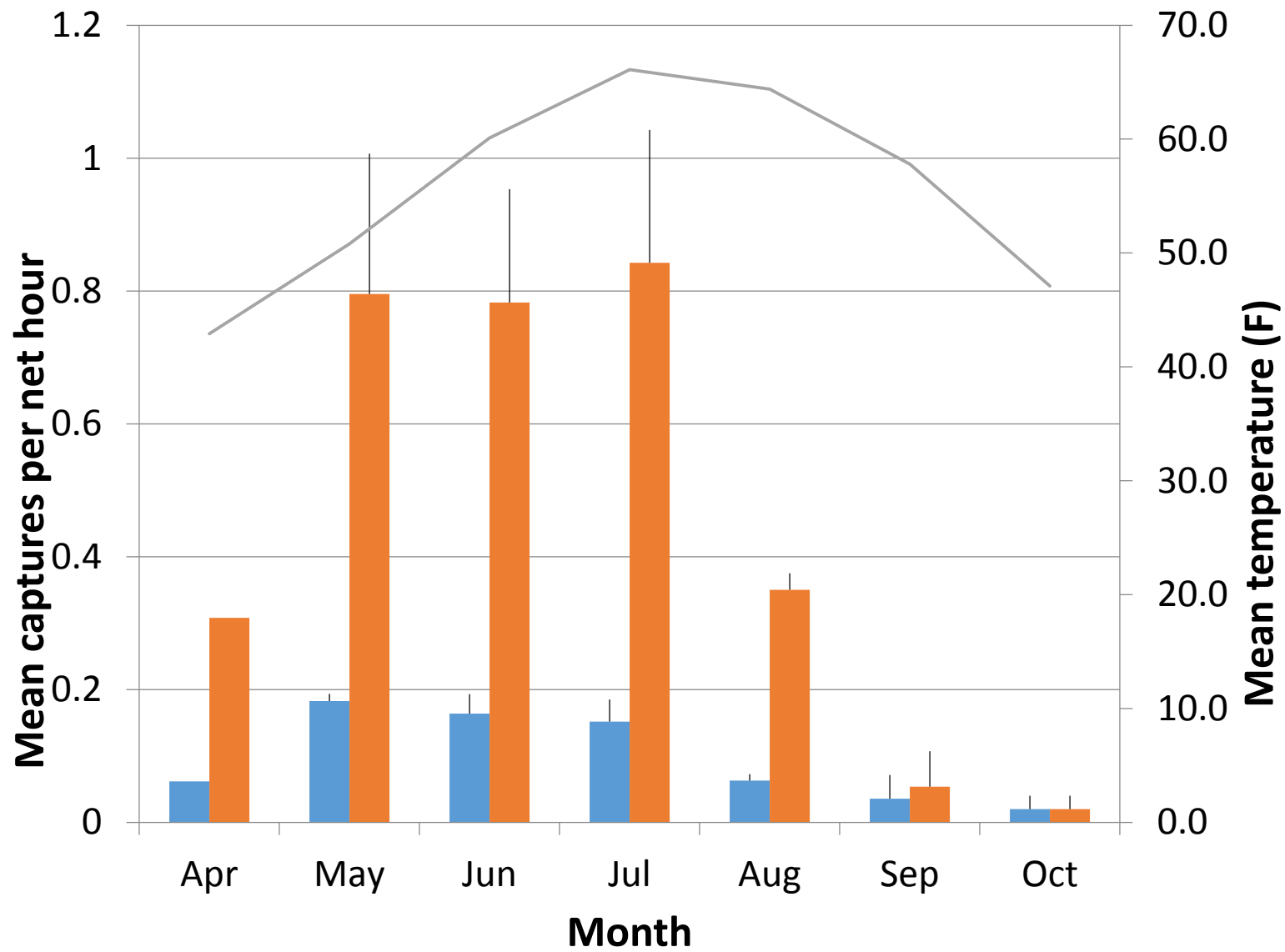
Arizona myotis

62%



73% females



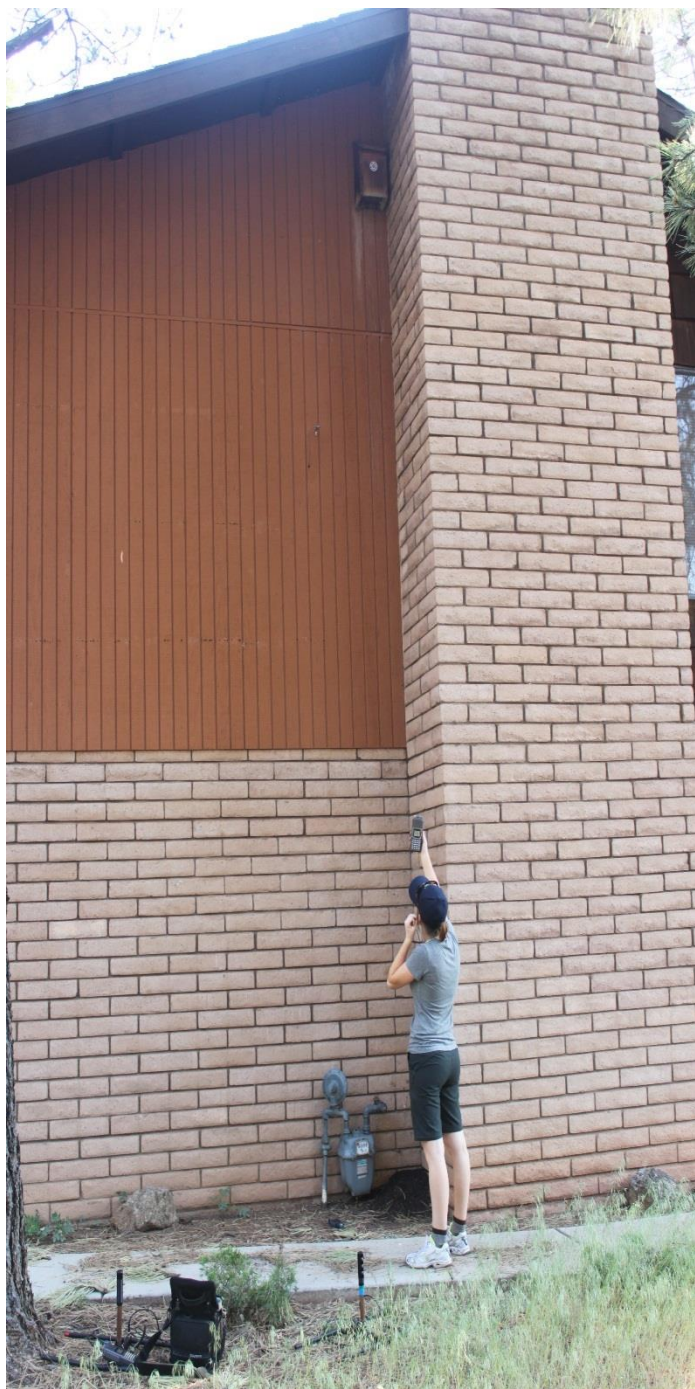


species/net hr

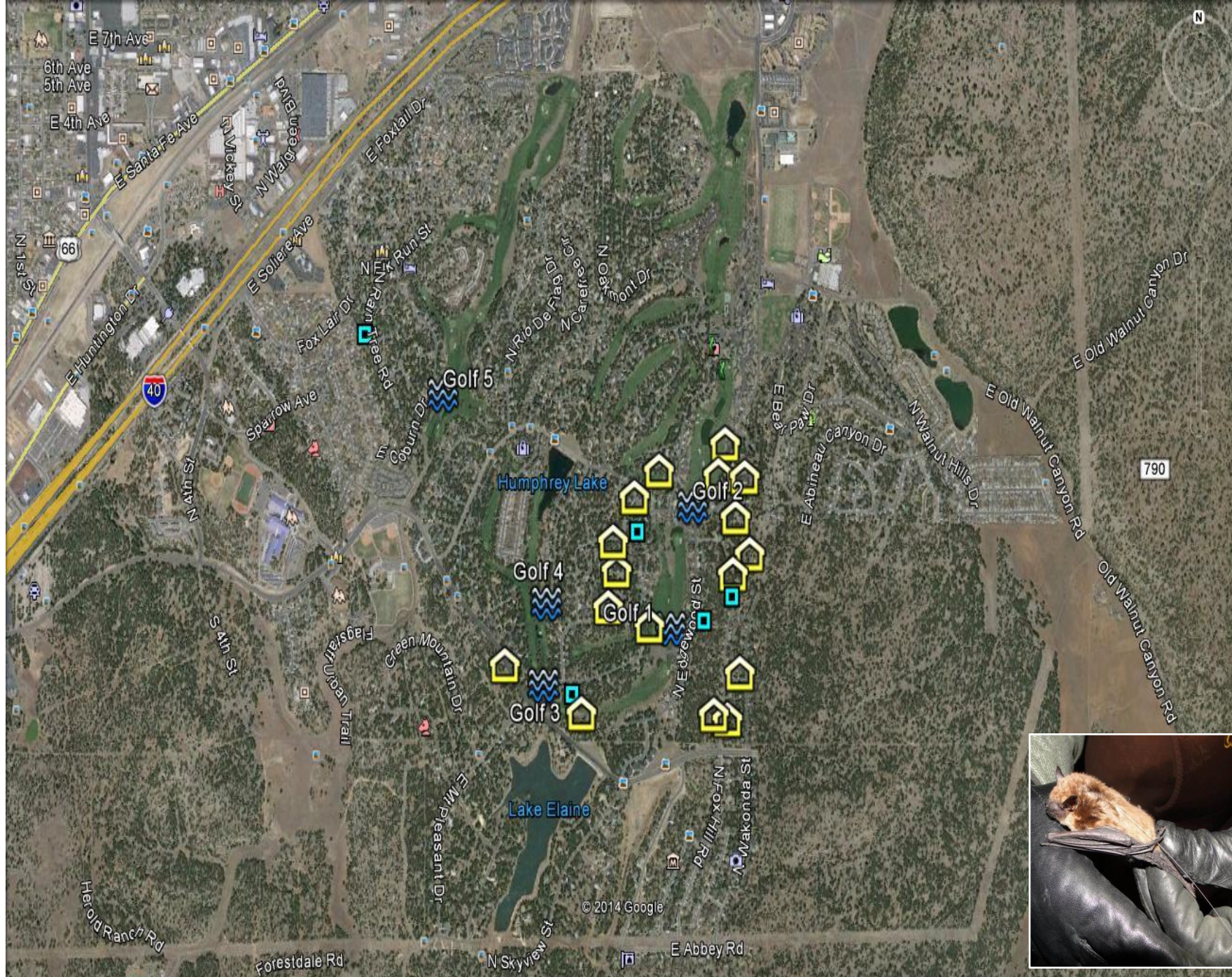
bats/net hr



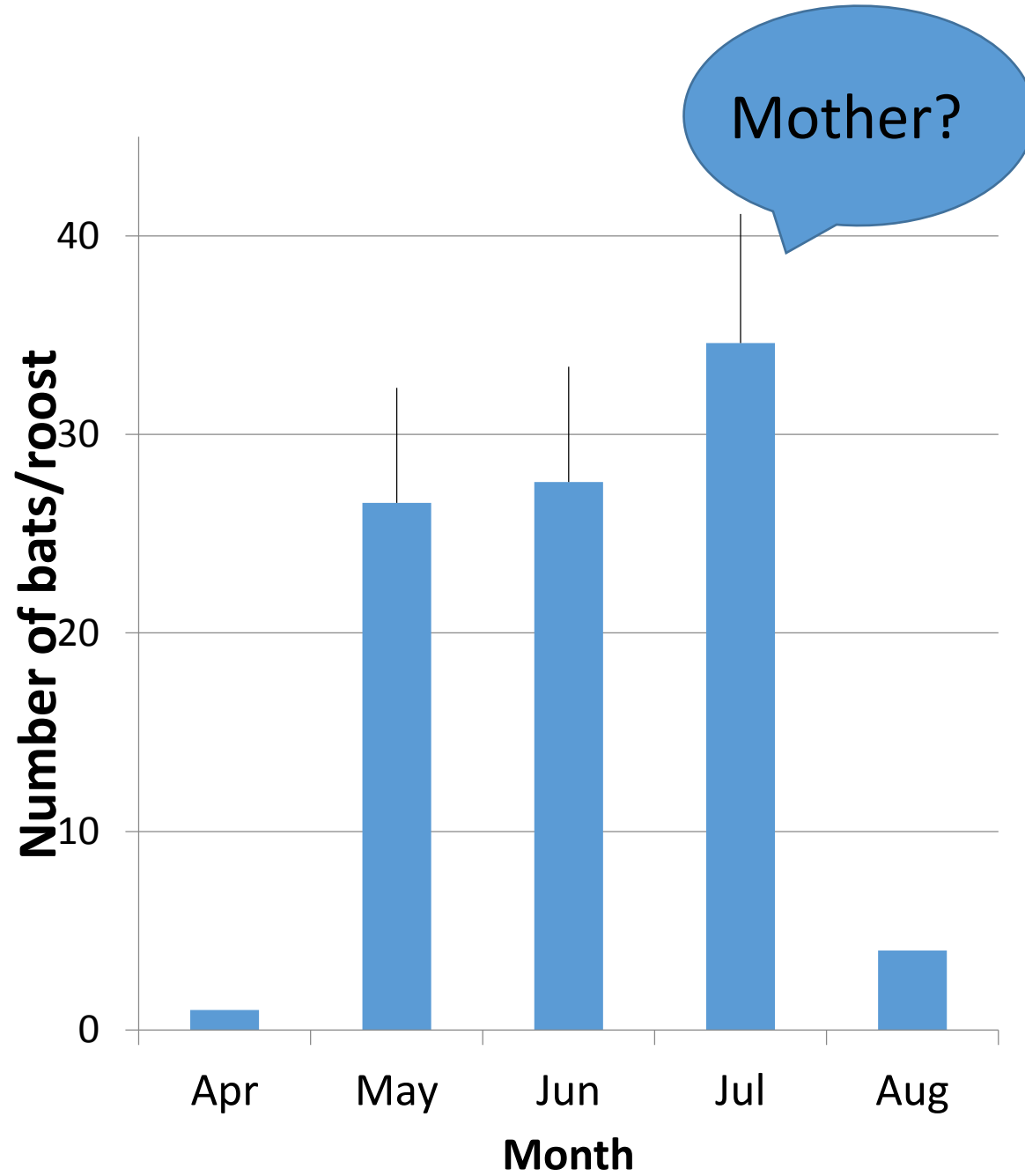












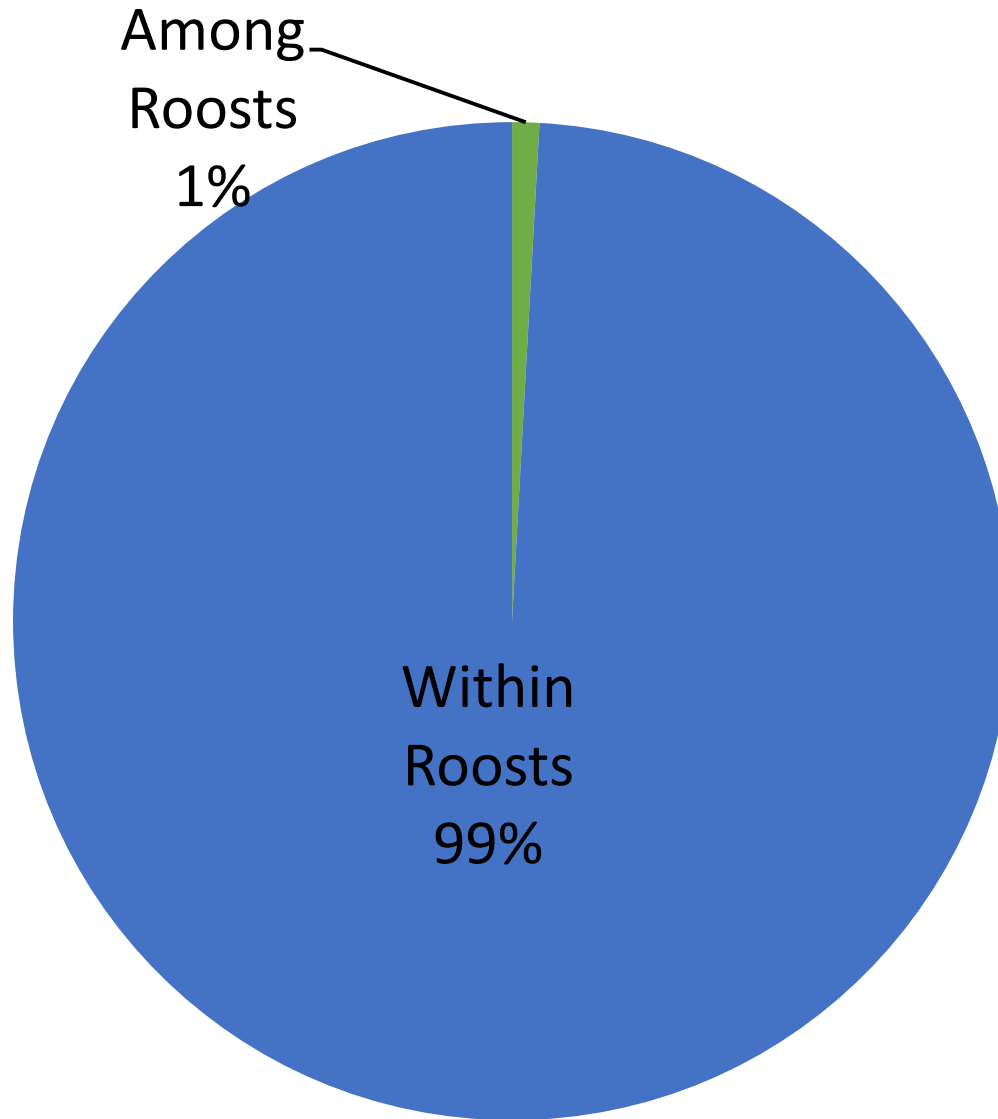


88  
genetic  
samples





# Percentages of Molecular Variance






## Legend

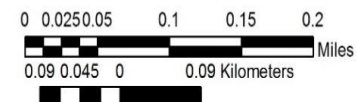
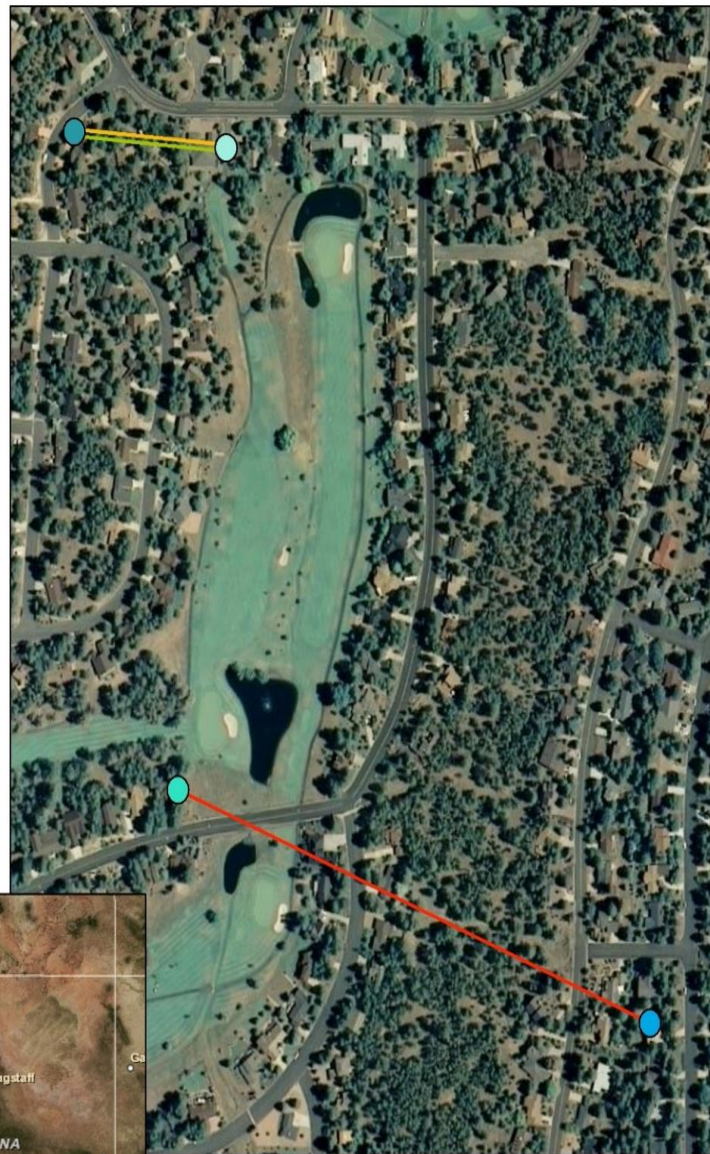
### Roost ID

-  Roost 1
-  Roost 2
-  Roost 3
-  Roost 4

### Recaptures

#### Bat\_ID

-  Female 1
-  Female 2
-  Female 3



## 30 June 2009 Northern Arizona

*Before sunset, we saw and heard an audibly echolocating bat attacking other flying bats. The echolocating bat pursued another bat to a tree, the two bats struggled, then fell to the ground. The attacking bat was biting the lower jaw of the other bat. The attacker finally released the other bat, both remained on the ground. Then the bat that had been attacked flew off. The bat that had initiated the attack was still on the ground acting strangely. The bat tested positive for rabies.*

**But... bats with rabies may die at roosts.**





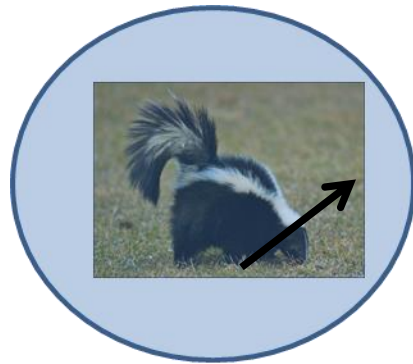
# Take home messages about bats

- Rabies seroprevalence (rabies is always around)
- Two bat species commonly live with humans
  - Seasonal in Flagstaff (summer peak)
- Genetic non-relatedness of big brown bats suggest potential for disease transfer
- Potential for interaction between bats and other wildlife can be at or away from a roost
  - Rabid bat found away from roost; attack noted
  - Bats can die in roosts and fall below
  - Skunks will take dead bats
- Limiting and available resources
  - Water (a key limiting resource for lactating bats)
  - Vacant or seasonally used houses
- Wildland Urban Interface proximity

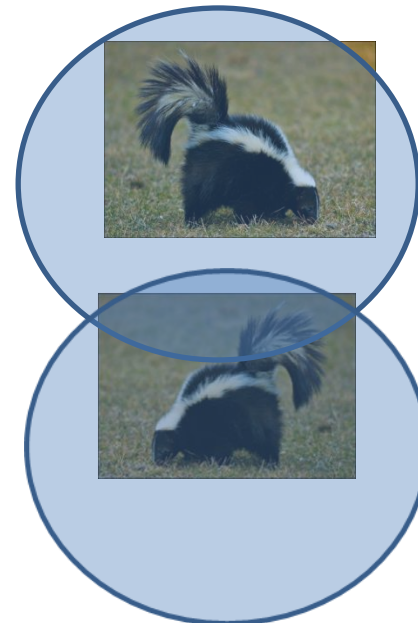
**Probability of disease spread depends on contacts among individuals**

## **How do you determine contacts among skunks?**

### **Proximity-sensing radio-collars**

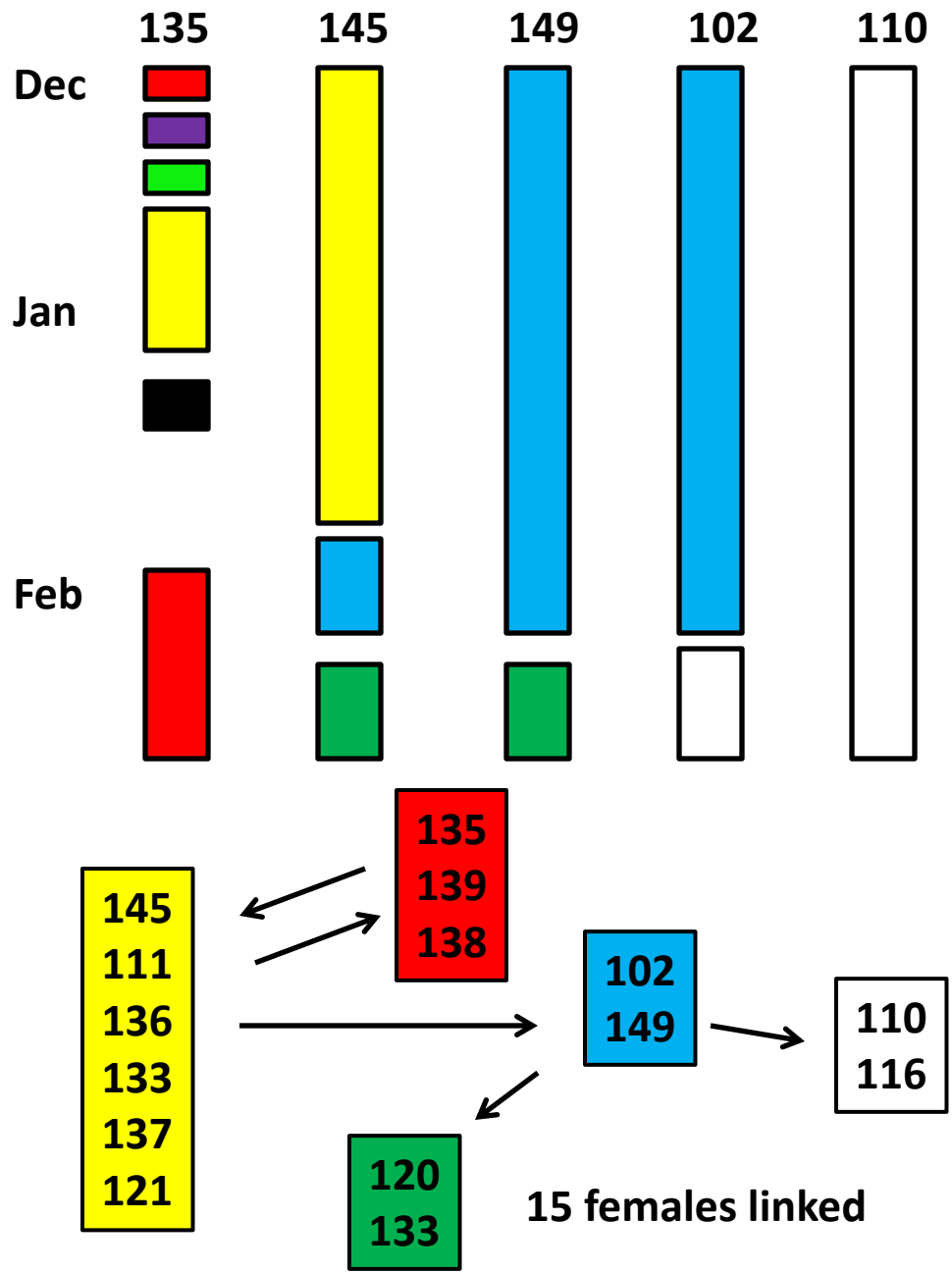
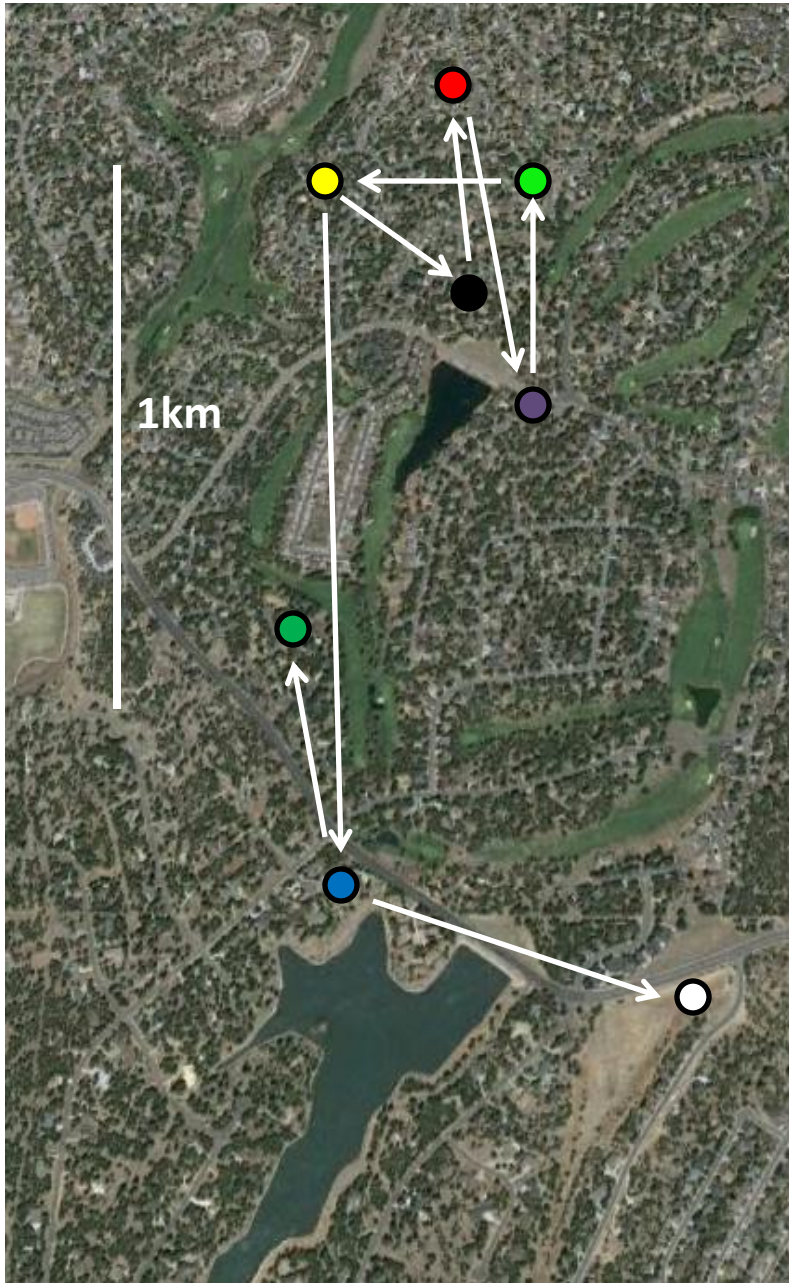


1-2m radius



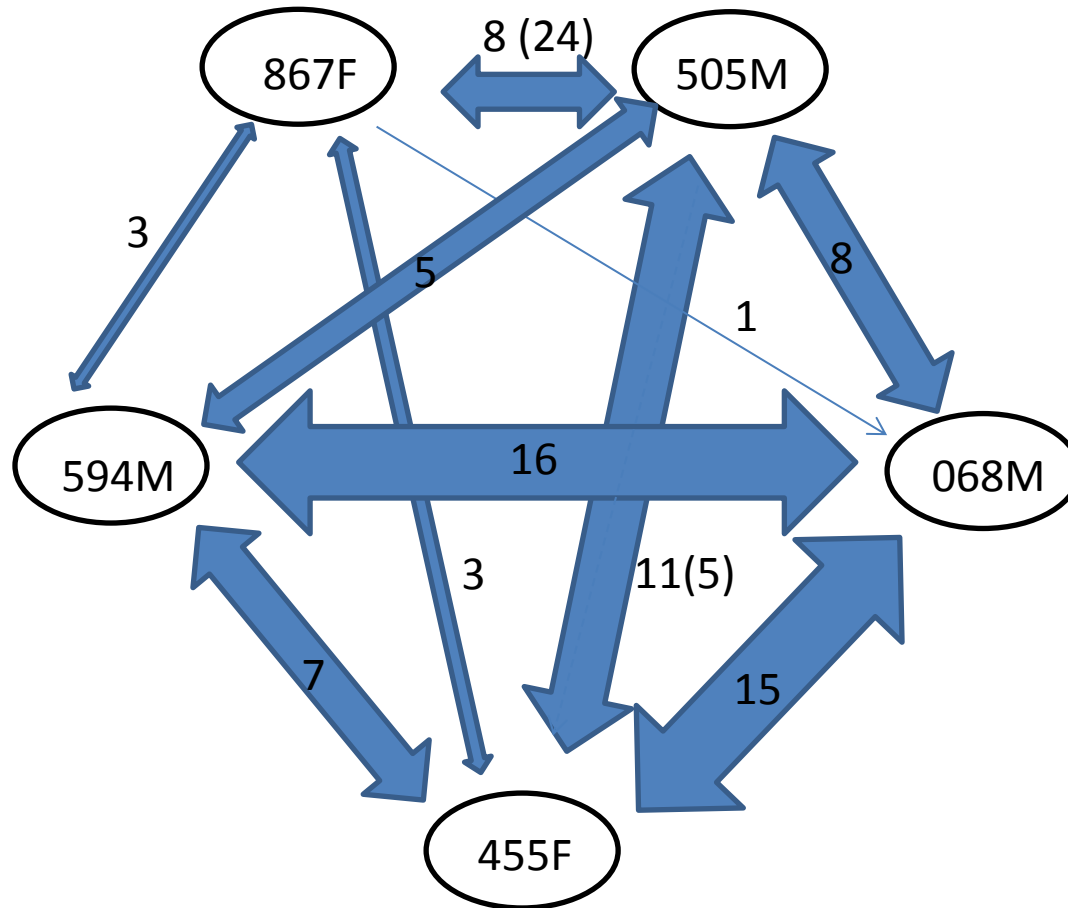
Contact recorded

# Winter contacts in Communal Dens - 1 Dec-15 Feb 2011-2012





**Summer-Fall Contacts University Heights, Flagstaff, AZ  
Sep 9-October 24 2011. Numbers = # nights (out of 45)  
skunks came within 1-2m**



6 -15 different dens used per individual

# Where might summer - fall contacts occur?

We focused on two common sources of human-provided food:

## 1) Bird seed spilled below feeders

55 million Americans feed birds



## 2) Pet food left out for domestic and feral cats

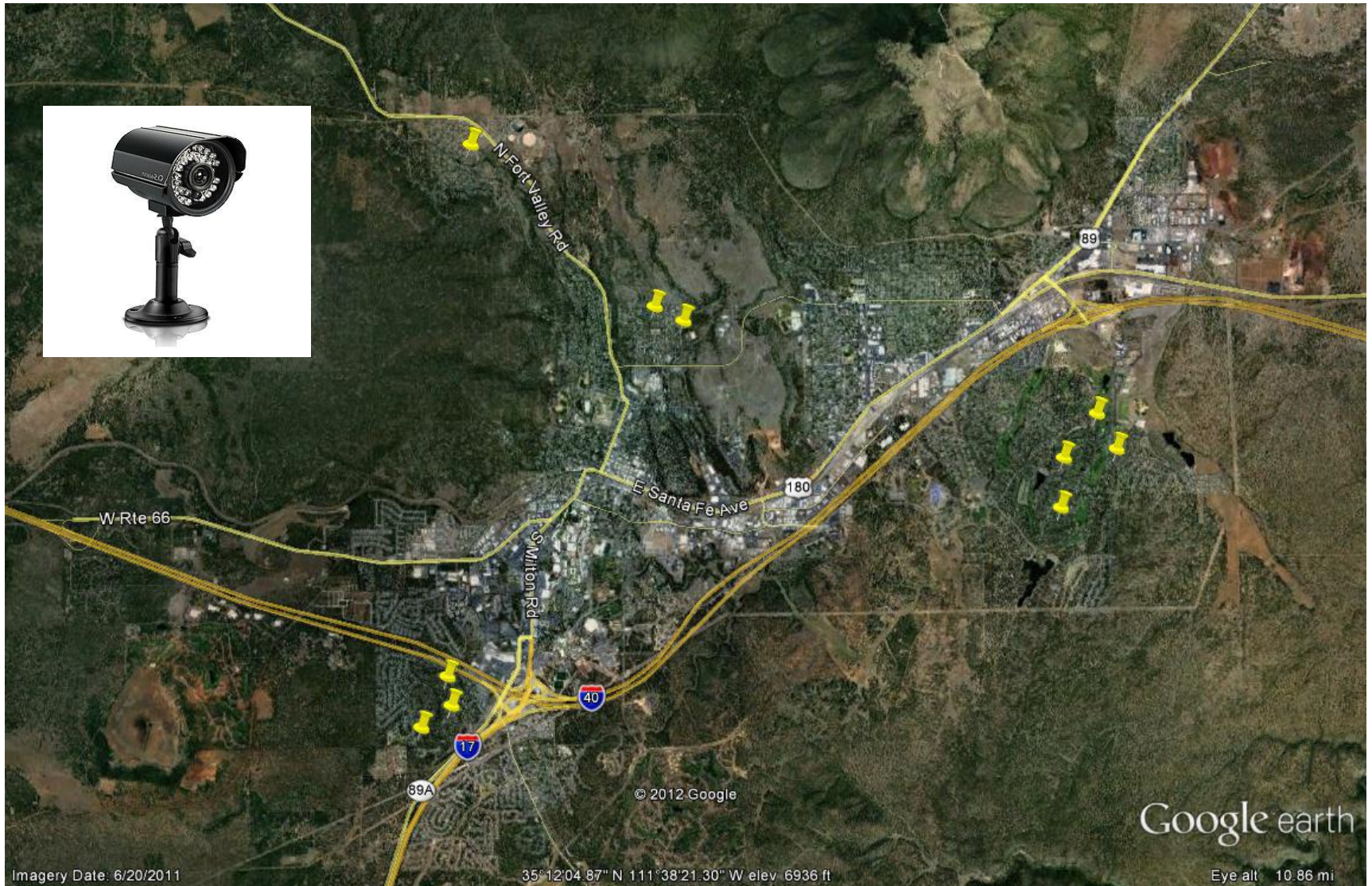
67 million pet owners

55 million feral cats








# Methods: 10 bird feeders in use for months to years in 4 different neighborhoods of Flagstaff, AZ Summer 2012

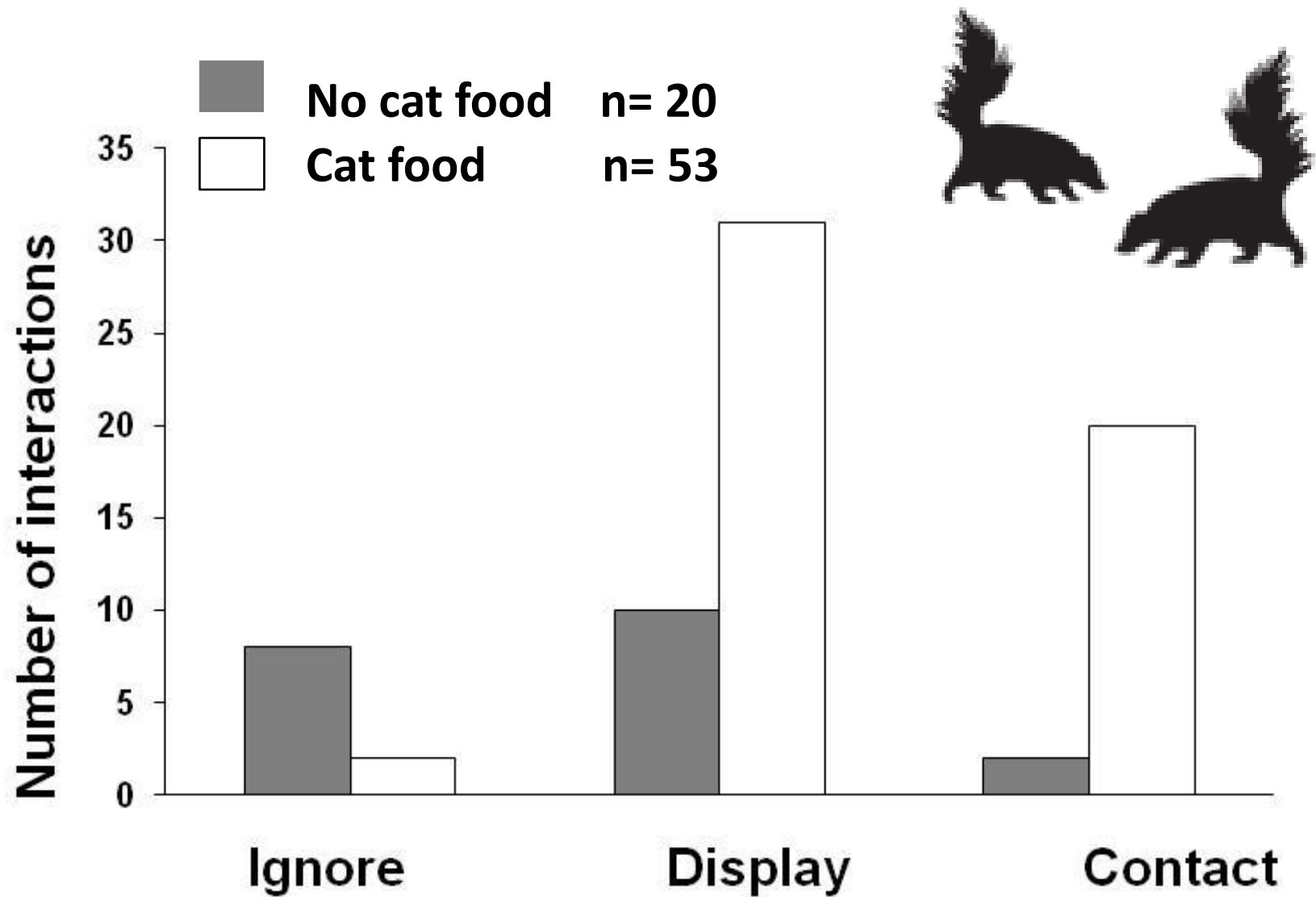


# Results - Visitation

		<u>Bird seed</u>	<u>Seed + Cat food</u>
	<u>Skunks</u>		
	Sites	10/10	10/10
	Visits	167	384**
	Nights	41/50	50/50
	<u>Cats</u>		
	Sites	9/10	9/10
	Visits	30	72**
	Nights	20/50	26/50
	<u>Raccoons</u>		
	Sites	5/10	6/10
	Visits	11	50**
	Nights	9/50	23/50**



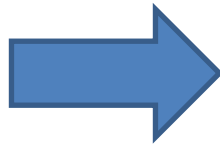
# Skunk-Skunk





# How is rabies transferred from bats to skunks?

**Big Brown Bat**



**Striped Skunk**



**Scavenging of dead or dying bats?**





*Ambush IR*

10/7/2013 7:38 PM



THANK YOU!

